CANADA COMMUNICABLE DISEASE REPORT

CCDR

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Canada has maintained its measles elimination status, despite a rising number of measles cases in 2014, because of prompt clinical and public health responses that have limited the length of outbreaks to less than 12 months. Learn how to effectively stop a measles outbreak in a community that is known to be under-vaccinated due to religious beliefs and read about developments that are currently being evaluated to strengthen our capacity to maintain measles elimination in Canada. In our ID News section, read an update on the receding Ebola outbreak, the differential diagnosis for travellers with fever from Ebola affected countries and consider some early reflections on the implications of the outbreak for global health security.

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World Health Organization. **Ebola Situation Reports 2015**
http://apps.who.int/ebola/ebola-situation-reports

Upcoming conference

August 24-26, 2015: 9th International Conference on Emerging Infectious Diseases, Atlanta, Georgia, United States.
http://www.iceid.org

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Canada Communicable Disease Report

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Measles surveillance in Canada: Trends for 2014

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Abstract

Background: Measles elimination status was achieved in Canada in 1998. The Public Health Agency of Canada compiles evidence for the Pan American Health Organization to confirm that criteria for the verification of measles elimination continue to be met.

Objective: To describe measles activity in Canada for 2014 in order to support Canada's ongoing measles elimination status.

Methods: Using data captured by the Canadian Measles and Rubella Surveillance System and the Measles and Rubella Surveillance pilot project during 2014, the distribution of measles cases by demographics, immunization status and hospitalization were assessed, outbreak characteristics were summarized and genotypic and phylogenetic analyses were conducted and described.

Results: During 2014, 418 measles cases were reported by five provinces and territories for an overall incidence rate of 11.8 cases per 1,000,000 population. Case counts and incidence rates were highest among those five to 14 years of age and the majority of cases were not immunized. Overall, five percent of cases were hospitalized, most frequently the youngest and oldest age groups. Eighteen outbreaks were reported, the largest of which occurred in a non-immunizing religious community in British Columbia. Genotype information was available for 98% of measles events (18/18 outbreaks and 31/32 sporadic cases). Canada continued to meet or partially meet all four of PAHO's criteria for verification of measles elimination.

Conclusion: Despite significant measles activity in 2014, Canada continues to provide strong evidence that measles elimination status is being maintained.

Introduction

Measles elimination status was achieved in Canada in 1998, one year after the last endemic case was reported in 1997 (1). Since that time, the Public Health Agency of Canada (the Agency) has documented evidence to support the continued verification of measles elimination status in Canada (1, 2, 3). Measles elimination is defined as the absence of endemic measles transmission in a defined geographic area (e.g., region) for ≥12 months in the presence of a well-performing surveillance system (4). This evidence is based on surveillance data collected through enhanced surveillance systems and is supported by molecular methodology. Genotyping contributes to both public health follow-up and ongoing elimination efforts by providing information on links between cases, identifying possible sources of importation and demonstrating that no single genotype is continuously circulating (i.e., absence of endemic transmission) (5).

Although the interruption of endemic measles virus transmission was achieved in the Region of the Americas in 2002 (6), endemic transmission persists across the five other World Health Organization (WHO) regions (African, Eastern Mediterranean, European, South East Asian and Western Pacific). As such, Canada is at risk of importation of the measles virus. Further, despite high immunization coverage estimates for Canada (7), outbreaks of measles continue to occur (8) as immunization coverage is heterogeneous. In order to support the

documentation and verification of measles elimination status, the Pan American Health Organization (PAHO) has identified four essential criteria. (See text box.)

Four essential criteria for verification of measles elimination (9)

1. Verify the interruption of endemic measles cases for a period of at least 3 years from the last known endemic case, in the presence of high-quality surveillance.
2. Maintain a high-quality surveillance system sensitive enough to detect imported and import-related cases.
3. Verify the absence of endemic measles virus strains through viral surveillance.
4. Verify adequate immunization in the population.

Methods

Surveillance dataset

The Canadian Measles and Rubella Surveillance System (CMRSS) is an active, enhanced surveillance system in all Canadian provinces and territories. On a weekly basis, provinces and territories were asked by the Agency to submit a report on the number confirmed measles cases for that reporting week, or to submit a zero report. Three jurisdictions (British Columbia, Alberta and Newfoundland and Labrador) were also participating in the Measles and Rubella Surveillance (MARS) pilot project; a web-based near-real-time platform for reporting of suspect measles case investigations. All cases were assessed against the national case definition (10).

This report describes enhanced case data for confirmed measles cases with rash onset during the 2014 epidemiologic year (weeks 01 to 53, from December 29, 2013 to January 3, 2015), as reported by the provinces and territories.

Case report form

Data in CMRSS were collected using the national case report form for measles. The case report form collected information required to support the national objectives for measles surveillance in the following categories: case identifiers; background, exposure and clinical information; and laboratory information. The national case report form is available online (11).

Genotyping

All measles virus genotyping was performed at the Agency's National Microbiology Laboratory (NML). Appropriate clinical specimens (respiratory and/or urine specimens) collected from suspect or confirmed measles cases were submitted to the NML by provincial laboratories. The WHO standardized genotyping region of the 450 nucleotides encoding the carboxyl-terminus of the measles nucleoprotein, the N-450 (12) was amplified and sequenced from extracted nucleic acid. The sequences were aligned with WHO genotype reference sequences (13) and maximum parsimony phylogenetic trees were generated using MEGA6 software (14).

Data management and statistical analysis

CMRSS data were managed using Microsoft Access 2010. Blank fields were coded as missing values and fields for which a value was sought but was not available from the data source were coded as unknown. A data validation process was conducted with provinces and territories in March 2015 for all measles cases reported nationally in 2014.

The distribution of measles cases by demographics, immunization status and hospitalization were assessed. Genotypic and phylogenetic analyses were also described. Counts and proportions were determined for categorical variables, whereas means, medians or ranges were determined for continuous variables. Incidence rates were calculated using Statistics Canada July 1 population estimates for 2014 in units consistent with recommended PAHO indicators (cases per 1,000,000 population) (9). Elimination status was assessed against criteria established by PAHO (9).

An outbreak was defined as two or more confirmed cases linked, either epidemiologically or virologically or both (11). The current publicly-funded immunization schedule in the reporting province or territory was used to define whether a case was up to date for age with measles-containing vaccine (MCV) (15) at the time of rash onset. Cases aged less than one year and those born before 1970 were age-ineligible for vaccine and were classified as up to date for age regardless of reported immunization status. Those aged seven years or more and born after 1970 were defined as up to date with two doses. Finally, for those aged one to six years, either one or two doses were considered up to date according to the current schedule in the reporting jurisdiction. Descriptive epidemiological analyses were conducted with SAS Enterprise Guide 5.1 (16). As this report utilizes public health surveillance data, it was exempt from research ethics board approval.

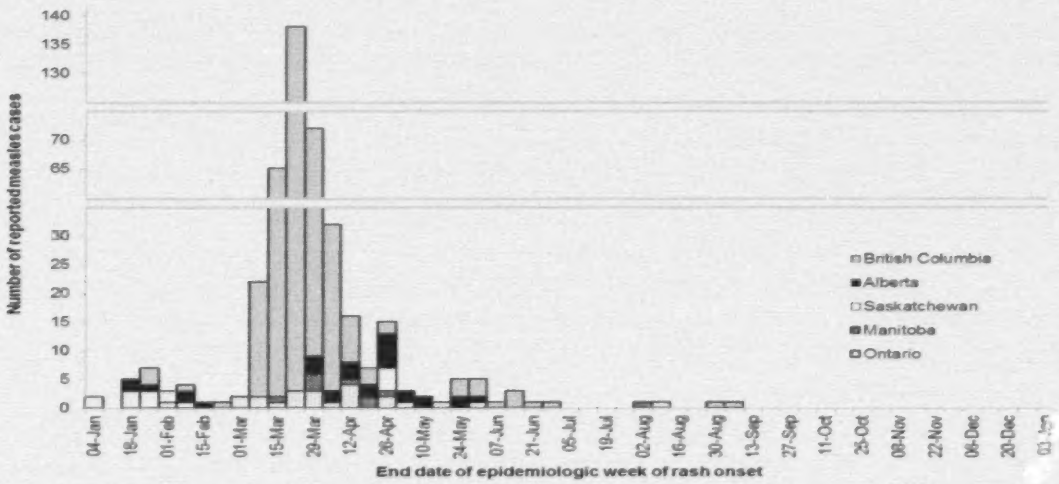
Results

Overview

In 2014, a total of 418 cases of measles were reported, of which 29.2% (n=122) were laboratory-confirmed and 70.8% (n=296) were epidemiologically linked to a laboratory-confirmed case. The overall incidence for this time period was 11.8 cases of measles per 1,000,000 population.

Cases were confined in time to a 36-week period starting in reporting week 01 (ending January 4, 2014) and continuing to week 36 (ending September 6, 2014). There was a continuous period of 17 weeks from week 37 (ending September 13, 2014) to week 53 (ending January 3, 2015) where no measles cases were reported. A maximum of 138 (33.0%) cases reported for a single epidemiologic week occurred in week 12 (ending March 22, 2014) during an outbreak in British Columbia (**Figure 1**).

Figure 1: Number of reported measles cases, by epidemiologic week of rash onset and reporting province or territory, Canada, 2014



Age, gender and geographic distribution

Cases of measles were most commonly reported among those aged five to nine years (29.9%) followed by those aged 10 to 14 years (25.4%) and 15 to 19 years (17.2%) (**Table 1**).

Table 1: Confirmed measles cases and incidence rates (per 1,000,000 population) by age group, gender and reporting province or territory*, Canada, 2014

Age group	M	F	BC	AB	SK	MB	ON	CA	Overall incidence rate
<1 year	10	4	4†	4	3	0	3	14	36.4
1 to 4 years	13	12	17	3	2	1	2	25	16.2
5 to 9 years	64	61	118	3	3	0	1	125	65.2
10 to 14 years	56	50	100	3	2	0	1	106	56.8
15 to 19 years	31	41	62	5	0	2	3	72	33.7
20 to 24 years	15	12	23	2	0	1	1	27	10.9
25 to 29 years	8	3	8	1	0	1	1	11	4.5
30 to 39 years	13	11	7	4	5	1	7	24	5.0
40 to 59 years	6	8	3	4	1	3	3	14	1.4
60 years or more	0	0	0	0	0	0	0	0	-
Total	**216**	**202**	**342†**	**29**	**16**	**9**	**22**	**418**	11.8
Incidence rate:	12.3	11.3	73.8	7.0	14.2	7.0	1.6	11.8	

*Provinces and territories that did not report any measles cases during 2014 were omitted from the table. These were: Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador, Yukon, Northwest Territories and Nunavut.

† Excluded from this count is one case of measles in a Canadian traveller who was exposed, infected and experienced the entire course of disease outside of Canada. This case is reflected in British Columbia's provincial case count.

Incidence rates were highest for those aged five to nine years, 10 to 14 years and less than one year (65.2, 56.8 and 36.4 cases per 1,000,000 population, respectively).

Notably, 3.3% (n=14) of cases were reported among infants too young to have received the first dose of MCV (aged less than one year) and 1.7% (n=7) of cases were presumed to have natural immunity against measles through prior infection (born before 1970). Approximately half (51.7%) of measles cases reported in 2014 were male.

Cases of measles were reported by five Canadian jurisdictions: British Columbia (n=342), Alberta (n=29), Ontario (n=22), Saskatchewan (n=16) and Manitoba (n=9). Incidence was highest in British Columbia, followed by Saskatchewan and Alberta (73.8, 14.2 and 7.0 cases per 1,000,000 population, respectively).

Immunization

Of the 418 cases of measles reported during 2014, 8.1% (n=34) were considered up to date for age with MCV at the time of rash onset (**Table 2**). However, 61.8% (n=21) of these cases were age-ineligible for immunization (infants aged less than one year [n=14] and adults born before 1970 [n=7]) according to the current National Advisory Committee on Immunization (NACI) recommendations (17). These were classified as up to date for age regardless of reported immunization history. Thus, overall only 3.1% (n=13) of cases were eligible to receive MCV and were considered to be up to date for age at the time of infection.

Table 2: Immunization status of confirmed measles cases, by age group and number of doses received, Canada, 2014

Age group	0 Doses *(Up to date with 0 doses)*	1 Dose *(Up to date with 1 dose)*	≥2 Doses *(Up to date with ≥2 doses)*	Unknown *(Up to date with unknown doses)*	Total *(Up to date)*
<1 year	12 *(12)*	1 *(1)*	0 *(-)*	1 *(1)*	14 *(14)*
1 to 4 years	23 *(0)*	1 *(1)*	0 *(-)*	1 *(0)*	25 *(1)*
5 to 9 years	105 *(0)*	0 *(-)*	0 *(-)*	20 *(0)*	125 *(0)*
10 to 14 years	90 *(0)*	0 *(-)*	2 *(2)*	14 *(0)*	106 *(2)*
15 to 19 years	61 *(0)*	2 *(0)*	4 *(4)*	5 *(0)*	72 *(4)*
20 to 24 years	22 *(0)*	0 *(-)*	1 *(1)*	4 *(0)*	27 *(1)*
25 to 29 years	9 *(0)*	0 *(-)*	1 *(1)*	1 *(0)*	11 *(1)*
30 to 39 years	5 *(0)*	6 *(0)*	3 *(3)*	10 *(0)*	24 *(3)*
40 to 59 years	3 *(2)*	0 *(-)*	1 *(1)*	10 *(5)*	14 *(8)*
60 years or more	0 *(-)*	0 *(-)*	0 *(-)*	0 *(-)*	0 *(-)*
TOTAL	**330 *(14)***	**10 *(2)***	**12 *(12)***	**66 *(6)***	**418 *(34)***

Based on immunization history, 91.9% (n=384) of cases were not considered to be up to date for age, including 14.4% (n=60) with an unknown immunization history that could not be assessed. Cases not considered up to date for age with MCV were most often reported as being aged five to nine years (32.6%), followed by 10 to 14 years (27.1%) and 15 to 19 years (17.7%).

One case of measles was reported in a child aged less than one year who had previously received one dose of MCV. However, vaccine was given shortly before rash onset and the case was considered to be unimmunized at the time of exposure.

Notably, three cases were reported among individuals who had received three doses of MCV. All three cases were imported from the Philippines and had received their first dose of MCV outside of Canada prior to twelve months of age.

Hospitalization

During 2014, hospitalization was indicated for 5.0% (n=21) of reported measles cases (**Table 3**).

Table 3: Hospitalization status of confirmed measles cases by age group, Canada, 2014

Age group	Total	Not hospitalized	Hospitalized	Unknown
		no. (%)	no. (%)	no. (%)
<1 year	14	7 (50.0)	5 (35.7)	2 (14.3)
1 to 4 years	25	22 (88.0)	3 (12.0)	0 (-)
5 to 9 years	125	124 (99.2)	1 (0.8)	0 (-)
10 to 14 years	106	106 (100.0)	0 (-)	0 (-)
15 to 19 years	72	72 (100.0)	0 (-)	0 (-)
20 to 24 years	27	26 (96.3)	1 (3.7)	0 (-)
25 to 29 years	11	10 (90.9)	1 (9.1)	0 (-)
30 to 39 years	24	16 (66.7)	5 (20.8)	3 (12.5)
40 to 59 years	14	8 (57.1)	5 (35.7)	1 (7.1)
60 years or more	0	0 (-)	0 (-)	0 (-)
Total	**418**	391 (93.5)	21 (5.0)	6 (1.4)

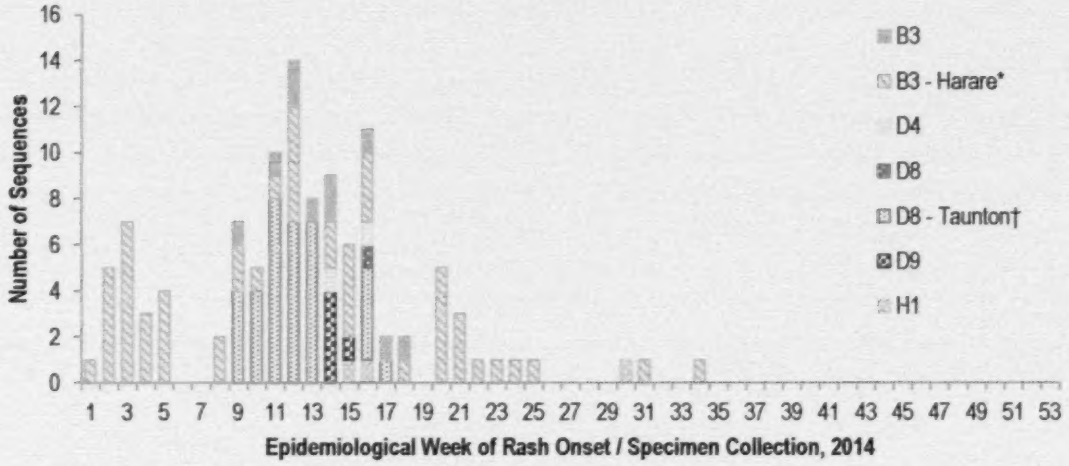
The youngest and oldest age groups experienced the most significant burden, with hospitalization reported for 35.7% (n=5) of cases aged less than one year, 35.7% (n=5) of cases aged 40 to 59 years and 20.8% (n=5) of cases aged 30 to 39 years. Hospitalization was infrequently reported among cases aged one to 29 years.

Note that hospitalization status was unknown for 1.4% (n=6) of cases.

Molecular epidemiology

During 2014, specimens were available to determine the genotype for 26.6% (n=111) of reported cases of measles. Cases with epidemiological links to a genotyped case are expected to have the same genotype, and so for surveillance purposes it is not necessary to genotype all cases from an outbreak. Thus in 2014, the genotype was determined for 98% of unique measles events where each outbreak or sporadic case is counted as a single event (18/18 outbreaks and 31/32 sporadic cases) far exceeding PAHO's indicator (**Table 4**). Measles genotypes were B3 (n=65), D8 (n=36), D9 (n=5), H1 (n=3) and D4 (n=2) (**Figure 2**).

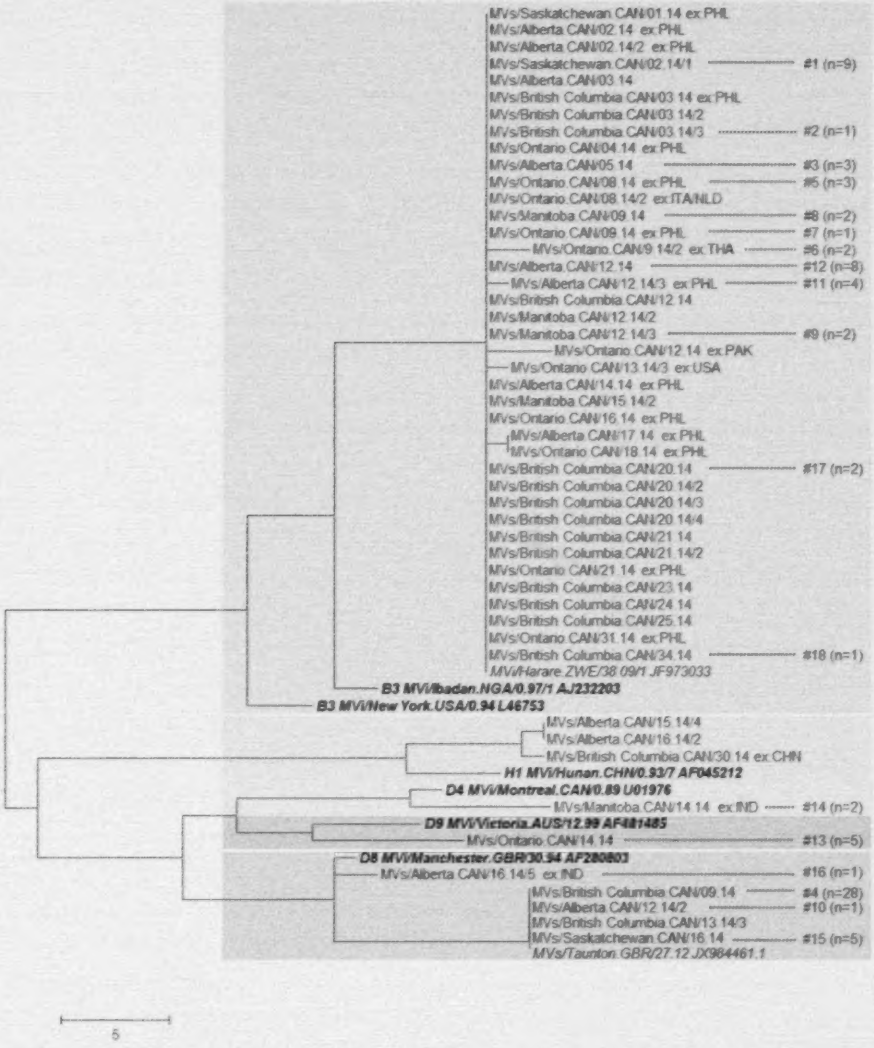
Figure 2: Distribution of measles genotypes detected in 2014 (n=111) by week of rash onset (if available, n=94) or specimen collection (n=17)



Epidemiological weeks are assigned in accordance with WHO guidelines (WHO.WER.2012;9(87):73) with week one beginning on the first Monday of the year.
*Genotype B3 sequences identical to sequence variant MVi/Harare.ZWE/38.09 (GenBank accession number JF973033).
†Genotype D8 sequences identical to sequence variant MVs/Taunton.GBR/27.12 (GenBank accession number JX984461).

Measles genotype B3 was circulating globally and was reported in over 40 countries in 2014 (18). In Canada, it was detected in 65 cases; 58.5% (n=38) of which were associated with 12 outbreaks (**Appendix**). It was most frequently imported from the Philippines (n=16) but was also identified in cases with travel history to USA (n=1), Europe (n=1), Pakistan (n=1) and Thailand (n=1). Fifty-five of the 65 genotype B3 N-450 sequences were identical to MVi/Harare.ZWE/38.09 (GenBank accession number JF973033), also known as the B3-Harare sequence variant (**Figure 3**). This sequence variant was reported globally and frequently linked with the Philippines, where there was a large outbreak in 2014 (GenBank accession number KJ634500). All Canadian cases with travel history to the Philippines had N-450 sequences identical to the B3-Harare sequence variant (n=13) or differed only by one nucleotide (99.8% identical, n=3). B3 sequence variants imported from places other than the Philippines differed from the B3-Harare sequence variant by one (99.8% identical, imported from USA, n=1), two (99.6% identical, imported from Thailand, n=1) or three nucleotides (99.3% identical, imported from Pakistan, n=1), providing laboratory confirmation that they were indeed unrelated measles events, imported from multiple sources.

Figure 3: Phylogenetic tree of measles N-450 sequences detected in Canada in 2014 (n=111)



LEGEND:
Relevant WHO reference sequences (13) are shown in bold, italic font. Sequence variants, assigned in the WHO measles sequence database (MeaNS) (20), are shown in italics. Canadian sequences are shown in regular font and are identified by their WHO name which indicates province and week of rash onset or specimen collection. Cases with travel history are identified with "ex:<3 letter country code>." Outbreaks are represented by a single sequence and are tagged with their outbreak number (**Appendix**). The number of identical sequences identified in the outbreak is provided in brackets. The remaining sequences (without an outbreak number listed) are from sporadic cases (n=31).

Measles genotype D8 was detected in 36 cases; 88.9% (n=32) of which were associated with four outbreaks including the large outbreak in BC (**Appendix**). Nearly all of the N-450 sequences (n=35) (many of which were associated with three outbreaks) were identical to the MVs/Taunton.GBR/27.12 sequence variant (GenBank accession number JX984461) (**Figure 3**). Globally, this genotype D8 sequence variant had been associated with a large, long-lasting outbreak in the Netherlands that began in 2013 (19). A second strain of genotype D8 was identified in 2014, associated with a small outbreak originating from India, where genotype D8 is endemic (20) (**Figure 3, Appendix**).

Outbreaks that were reported ranged in size from two to 325 cases (median: three cases). The majority (72.2%) of outbreaks were two generations or less and the median duration was 15 days (two generations). Reported outbreaks were determined to be genotypes B3 (n=12), D8 (n=4), D4 (n=1) and D9 (n=1).

The vast majority (84.4%, n=325) of outbreak-related cases occurred during a large outbreak of measles in British Columbia. This outbreak occurred in a non-immunizing religious community, where it is suspected that the source of the virus was an undocumented importation from the Netherlands, the location of a concurrent outbreak (19) in a religious community with historic precedent for importation of vaccine preventable diseases into Canada (1,21,22). This outbreak occurred predominantly among those aged five to 14 years. Further analysis of this outbreak is described elsewhere (8).

Canadian measles in the global context

Among the 418 measles cases reported in 2014, 6.0% (n=25) were imported. The majority of importations acquired disease in the Western Pacific region (the Philippines [n=18], China [n=1]), followed by the South East Asian region (India [n=2], Thailand [n=1]), the Eastern Mediterranean region (Pakistan [n=1]), the European region (Italy/ Netherlands [n=1]) and the Region of the Americas (United States [n=1]). The Philippines experienced a significant outbreak of measles in 2014, presumably a driver of the volume of importations that Canada experienced in that year.

Of the 25 reported importations, only nine (originating from the Philippines [n= 6], India [n=2] and Thailand [n=1]), are known to have resulted in secondary spread. All of the reported importations were individuals whose country of usual residence was Canada, who acquired measles during travel and were infectious following their return to Canada. Further, importations were distributed across almost every age group, but were most commonly reported among those aged less than one year or 15 to 19 years (16%, n=4 each).

Maintenance of measles elimination

PAHO has established four essential criteria for the ongoing verification of measles elimination (9). Canada met or partially met all of these criteria in 2014 (**Table 4**).

Table 4: Pan American Health Organization essential criteria for the verification of measles elimination

Criterion	Indicator	Description
Verify the interruption of endemic measles cases for a period of at least 3 years from the last known endemic case in the presence of high-quality surveillance	Zero cases of endemic transmission	**Criterion met** Canada achieved measles elimination status in 1998. Since then, molecular and epidemiological surveillance continues to demonstrate that no viral strain has circulated for a period of one year or more in Canada. Previously-presented evidence supporting the verification of interruption of endemic measles in Canada from 1998 to 2013 is available online (1, 2, 3).
Maintain high-quality surveillance sensitive enough to detect imported and import-related cases	> 2 suspect cases per 100,000 population adequately investigated	**Criterion partially met** As only confirmed cases of measles are nationally notifiable in Canada, this indicator cannot be directly assessed. However, using data obtained by the Measles and Rubella Surveillance Pilot Project, the national rate of measles-like illness investigation rate was estimated to be between 12 per 100,000 population (2006, non-outbreak year) and 19 per 100,000 population (2011, outbreak year).
Verify the absence of endemic measles virus strains through viral surveillance	Measles genotype assessed in 80% of outbreaks	**Criterion met** At least one case was genotyped for 100% of outbreaks in

		2014.
Verify adequate immunization in the population	95% of population cohorts aged 1 to 40 years have received a measles-containing vaccine	**Criterion partially met** A national immunization registry does not currently exist in Canada; therefore this criterion cannot be directly assessed. However, the 2011 Childhood National Immunization Coverage Survey estimated first dose MCV coverage among 2 year olds to be 95.2% and second dose MCV coverage among 7 year olds to be 94.9% (7). However, note that these are average values; coverage is heterogeneous and will be higher in some areas and lower in others

Discussion

During 2014, there were 418 confirmed cases of measles reported in Canada, the second-highest total since measles elimination was achieved in 1998. In large part however, these cases were attributable to an outbreak in a non-immunizing religious community (8). Notably, the majority (72.2%) of outbreaks in 2014 were limited to two generations or less, with the median duration for an outbreak being 15 days (two generations). This suggests that these events were well-controlled by a combination of high immunization coverage rates and interventions implemented by public health.

The burden of measles was highest among those aged five to 14 years in terms of the incidence of disease, corresponding to the age group distribution of cases reported during an outbreak in British Columbia in a non-immunizing religious community. However, the burden was also appreciable for those aged less than one year and 40 to 59 years, with respect to morbidity (i.e., hospitalization). Given the limitations of morbidity data captured by CMRSS and MARS and the absence of mortality data, this is an incomplete representation of the true burden of disease caused by measles in Canada.

Five genotypes (B3, D8, D9, H1 and D4) were detected in 2014, imported from every WHO region except the African region. While Canada achieved measles elimination status in 1998, importations of measles will continue to occur as the virus circulates widely in other countries. According to the WHO, over 201,000 confirmed cases of measles were reported worldwide in 2014, primarily in the Western Pacific region (23). The United States also reported the highest yearly total of measles cases since they achieved elimination in 2000 (24). Global travel coupled with significant outbreaks in other areas of the world can increase the risk of importation and subsequently the opportunity for the spread of measles within Canada. Large domestic outbreaks, such as the one reported by British Columbia, highlight areas for improvement in population-level immunity and the ongoing importance of maintaining high immunization coverage with MCV.

As in previous years, Canada met or partially met all of the criteria for verification of measles elimination set out by PAHO. Genotyping was completed for 98% of unique measles events in 2014. Molecular methods continue to play a key role in supporting epidemiologic surveillance for the criteria Canada met in 2014: verifying the interruption of endemic measles cases for a period of at least three years from the last known endemic case, in the presence of high-quality surveillance and verifying the absence of endemic measles virus strains through viral surveillance. The criteria Canada partially met (maintaining high-quality surveillance sensitive enough to detect imported and import-related cases and verifying adequate immunization in the population) present opportunities to strengthen current activities related to Canada's ongoing commitment to measles elimination, summarized elsewhere (25).

Limitations

Measles-related mortalities are not currently captured by CMRSS or MARS. However, it is likely that death following acute measles infection would be described by alternative sources of information (e.g., Statistics Canada's Vital Statistics or the media). While limited morbidity data are available, detailed information such as duration of hospitalization or the nature and severity of any complication are not currently described by CMRSS or MARS.

Immunization status could not be assessed for 14.4% (n=60) of cases. Further, immunization status for cases aged one to six years was defined using the current provincial or territorial schedule which differs across jurisdictions. While this respects the health context in which the case occurred, it differentiates between similar individuals based on a factor that may not contribute to their vulnerability to measles.

Conclusion

Despite significant measles activity in 2014, Canada continues to provide strong evidence for maintained measles elimination status.

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Conflict of interest

None

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Appendix: Summary of measles outbreaks in Canada, ordered by earliest date of rash onset, 2014

#	Prov.	No. of cases	Duration (in days) (Generations)	Genotype	Description
1	SK	10	32 (3)	B3 – Harare*	• The index case was an importation from the Philippines in an unimmunized Canadian traveller. • Subsequent spread was reported among contacts in a variety of settings.
2	BC	2	14 (2)	B3 – Harare*	• The index case in this outbreak had an unknown source of exposure. • The secondary case was epidemiologically linked to the index case.
3	AB	3	4 (1)	B3 – Harare*	• The primary case was not identified. • This cluster of three cases were presumed to have shared a common source of exposure based on their dates of rash onset.
4	BC	325	107 (9)	D8 - Taunton†	• The primary case was not reported, but was believed to have been an importation from the Netherlands. • Subsequent spread occurred within a non-immunizing religious community primarily in a school-based setting. • Very few cases related to this outbreak were reported outside of the religious community.
5	ON	4	26 (3)	B3 – Harare*	• The index case in this outbreak was an importation from the Philippines in an unimmunized child. • The secondary cases were household and school contacts.

6	ON	2	12 (2)	B3	• The index case in this outbreak was an importation from Thailand in an immunized Canadian traveller. • The secondary case was a household contact of the case.
7	ON	3	19 (2)	B3 – Harare*	• The index case in this outbreak was an importation from the Philippines, who also travelled to China. • The two secondary cases were exposed to measles in a health care setting.
8	MB	2	15 (2)	B3 – Harare*	• The index case in this outbreak had an unknown source of exposure. • The secondary case was a close household contact of the index case.
9	MB	2	21 (2)	B3 – Harare*	• The index case in this outbreak had an unknown source of exposure. • The secondary case was exposed in a healthcare setting.
10	AB	2	5 (1)	D8 - Taunton†	• The primary case for this outbreak was unknown. • The two reported cases were epidemiologically linked and were presumed to have a common source of exposure.
11	AB	4	27 (3)	B3	• The index case was an importation from the Philippines in an unimmunized Canadian. • The secondary cases were import-related, epidemiologically-linked cases in the same health unit.
12	AB	9	53 (5)	B3 – Harare*	• This event includes two simultaneous importations from the Philippines (recent immigrants who travelled together). • The secondary cases were import-related cases.
13	ON	5	12 (1)	D9	• The index case was a visitor from China epidemiologically linked to an ongoing outbreak there. • All five cases were epidemiologically linked to this one visitor.
14	MB	2	13 (2)	D4	• The index case in this outbreak was imported from India. • The secondary case had a weak epi-link to the index case.
15	SK	5	9 (2)	D8 - Taunton†	• The primary case for this event was not identified, but is presumed to be the common source of exposure for the reported cases. • The reported cases compose two clusters with no travel or source of exposure identified.
16	AB	2	13 (2)	D8	• The index case in this outbreak was an importation from India. • The secondary case was epidemiologically linked to the index case.
17	BC	2	18 (2)	B3 – Harare*	• The index case had an unknown source of exposure. • The secondary case was exposed in a health care setting.
18	BC	2	9 (2)	B3 – Harare*	• The index case had an unknown source of exposure. • The secondary case was a household contact.

*Genotype B3 sequences identical to sequence variant MVi/Harare.ZWE/38.09 (GenBank accession number JF973033).
†Genotype D8 sequences identical to sequence variant MVs/Taunton.GBR/27.12 (GenBank accession number JX984461).

Outbreak of measles in an unvaccinated population, British Columbia, 2014

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Abstract

Background: Although Canada eliminated endemic measles in 1998, outbreaks are expected to occur periodically through import-related transmission in geographically clustered unvaccinated communities. In the spring of 2014, in association with an outbreak in the Netherlands, a large measles outbreak occurred in British Columbia in a community unvaccinated for religious reasons.

Methods: Case finding with assistance of the local community, its school and religious leaders and local health care providers was conducted to identify confirmed, probable and suspect cases. Measles control guidelines were implemented with limited uptake of measles-containing vaccine (MCV) but higher adherence with infection control measures and travel restrictions.

Results: A total of 433 cases (325 confirmed and 108 probable) were identified. Rash onset ranged from February 22 to June 9, with 98% during March and April. Fifty-seven percent of cases were students of one school. The median age of cases was 11 years and 68% of cases were aged five to 19 years. Ninety-nine percent of cases were unvaccinated. One case had encephalitis and recovered. Only five cases occurred outside of the affected community. Genotyping results were consistent with importation from the Netherlands outbreak.

Conclusion: This outbreak in a community with low-vaccination rates affected largely the pediatric-age population, compatible with acquisition of measles immunity by adult members due to prior wild-type measles infection. Although vaccine hesitancy persisted in this population, containment of the outbreak was facilitated by a high degree of community cooperation with infection control measures and restriction of movement.

Introduction

Measles is a highly contagious, acute viral illness preventable by measles vaccine. To achieve the Pan American Health Organization (PAHO) goal of measles elimination, British Columbia (BC) introduced a two-dose measles vaccination program for children in 1996 (1, 2). Canada has been free of endemic measles (defined as an identifiable chain of transmission lasting over 12 months) since 1998 and measles was declared eliminated in the Americas in 2002. The status of measles elimination has been recently reviewed by the International Expert Committee (3).

Measles cases and outbreaks continue to occur in Canada due to periodic importation. Since Canada has been free of endemic measles, BC has experienced two substantial outbreaks. The first outbreak in 2010 resulted in 82 confirmed and clinical (also referred to as 'probable') cases with province-wide transmission and was associated with two separate importations during the Winter Olympic Games held in Vancouver (4, 5). The second and substantially larger outbreak occurred in 2014 and is described in this report.

The 2014 outbreak occurred in the eastern part of the Fraser Valley health region in a Netherlands Reformed Orthodox Protestant community with a population estimated at 1,200 individuals. This community is known to object to vaccination. This population is not socially or geographically isolated, resides in a semi-rural agricultural part of the region and has strong ties to the Netherlands. The outbreak occurred at the tail end of a measles outbreak in the Netherlands which had begun in May 2013 and ended in March 2014. The Netherlands outbreak resulted in approximately 2,600 reported cases of measles, 182 hospitalizations among children and the death of

one child from complications of measles (6, 7). The same Netherlands outbreak had resulted in two earlier importations into the Fraser Health Authority region in August and November 2013, neither of which resulted in widespread transmission and an importation of measles into Southern Alberta resulting in 42 confirmed cases from October 2013 through January 2014 (8).

Outbreak investigation

On March 6, 2014, Fraser Health Authority was notified by the principal of a school in the eastern part of the region that about one-third of a grade three class and about 10% of the remaining students were absent from school due to a rash illness. Almost all students at the school were not vaccinated against measles due to religious belief.

The health unit initiated case confirmation and case finding by calling families of school children to identify earlier and current cases. The school families characteristically had a large number of children per family and a high degree of interconnection through school, church and extended family relationships. Most families with one or more ill children had not sought medical care and declined medical assessment and laboratory testing.

Case finding and data collection activities

Confirmed, probable and suspect measles cases are reportable under the Communicable Disease Regulations under the Public Health Act in British Columbia (9). The provincial case definition for measles was used for classification of cases, but modified to include 'epidemiologically-linked confirmed' (epi-linked) cases, i.e., students and staff of the affected school that had measles-compatible clinical illness (10). This was based on the assumption that school attendance resulted in potential for measles exposure on par with exposure to a laboratory-confirmed case.

A modified abbreviated case report form based on the provincial form for measles reporting was used during the outbreak and submitted for data entry to the BC Centre for Disease Control. The provincial case report form was submitted on each case at the end of the outbreak (11). Variables included demographic data, signs and symptoms, immunization history, complications and outcome, laboratory samples collected, travel and exposure history, healthcare worker occupation, student status, residence in a communal setting and aggregate information about contacts.

Laboratory methods

The British Columbia Public Health Microbiology and Reference Laboratory performed molecular testing for detection of viral RNA on nasopharyngeal swabs and urine by reverse transcription real-time polymerase chain reaction (RT-PCR). Serologic testing was conducted using the Siemens Enzygnost® Anti-Measles-Virus/IgG and Anti-Measles-Virus/IgM immunoassays. The National Microbiology Laboratory (NML) in Winnipeg performed confirmatory RT-PCR testing and conducted virus genotyping for all RT-PCR-confirmed specimens.

Public health measures

Recognizing the high probability of spread of measles from the Netherlands to the associated BC population, local Fraser Health Authority health units had made concerted efforts prior to this outbreak in the summer of 2013 to strengthen relationships with the Dutch Reformed communities, particularly with the schools operated in association with churches. These relationships were facilitated by a community resource nurse employed by Fraser Health Authority who was a member of the Dutch Reformed community. Advice was also sought from public health professionals in the South Zone of Alberta where similar communities reside. Recognizing that most community members would not accept measles vaccine even in the context of the outbreak, discussion between public health authorities and the community focused on common values and goals. Values included shared responsibility for community well-being, the need to protect vulnerable members of society and the desire not to inflict harm. Goals included timely reporting of cases, minimizing transmission outside of the community and optimizing infection control measures.

Case and contact management was conducted according to BC measles control guidelines (12). Post-exposure prophylaxis with measles, mumps and rubella (MMR) vaccine as well as immune globulin (IG) were offered. Almost all contacts within the religious community declined vaccine but IG receipt was deemed in keeping with

religious doctrine because it was seen by the community as 'treatment'. Community members willing to be vaccinated were provided with private venues to obtain this service to avoid being ostracized by their faith community. Cases were advised to self-isolate following prodrome onset and for four days following rash onset and exposed individuals to self-quarantine for a period of 21 days. Arrangements were made with hospital laboratories for diagnostic services through an alternate payment mechanism for community members without Medical Service Plan numbers. Laboratory testing was not encouraged by the public health nurses once the outbreak was confirmed to avoid exposing the general public in settings such as waiting rooms following some potential exposures in local health care settings.

Fraser Health Authority rapidly instituted control measures in the Fraser Valley area and worked alongside many groups within the affected community including school and religious leaders. Since the outbreak started the week before spring break, families of cases and contacts were asked not to travel. These travel restrictions were agreed upon with the school board and were supported by community leaders. The principal closed the school on March 7, two days prior to spring break and under order of the medical health officer, the school remained closed for an additional week beyond the break, reopening on April 1.

Fraser Health Authority also advised measles vaccination for unvaccinated and under-vaccinated residents of the area through a variety of communications and immunization services that were offered by the health authority as well as through local pharmacies and physician's offices. For the surrounding population that accepted vaccine, MMR vaccine was offered as a second dose to toddlers as early as one month after the first dose (otherwise, the routine schedule in BC provides a second dose at four to six years). All Fraser Health Authority staff were required to have proof of measles immunity in order to work in a patient care setting. The outbreak was declared over on April 29.

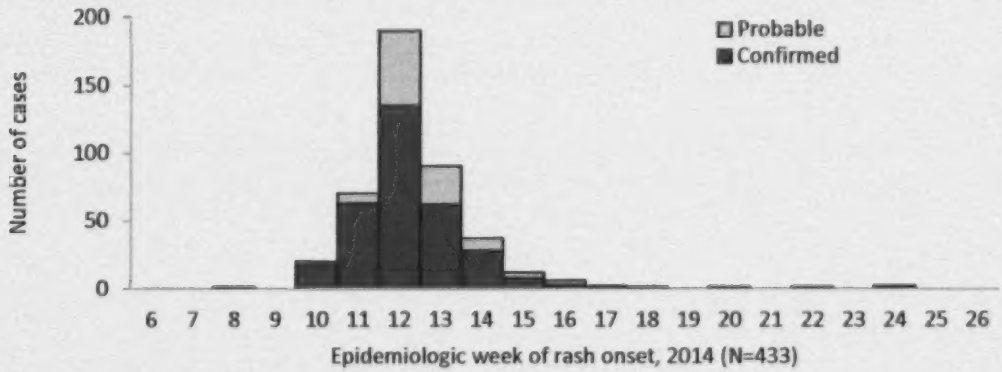
Statistical analysis

Descriptive statistics were calculated using Stata 13 (StataCorp. (2013). Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

Results

A total of 433 cases (325 confirmed and 108 probable) were identified among BC residents during the outbreak. The index case had rash onset on February 22, 2014 (epi-week 8). Identified congregate settings where transmission from this case occurred were at church on the second day of the rash and school on the third day. Most cases (425, 98%) had rash onset in March and April (epi-weeks 10 to 16) and the last case had rash onset on June 9, 2014 (epi-week 24) (**Figure 1**).

Figure 1: Measles outbreak epidemic curve by case status and epidemiologic week of rash onset, British Columbia, 2014



The outbreak was focused in one school in the region, which had approximately 360 students from kindergarten to grade 12. Over half of all cases were students or staff of this school (248 cases, 57%; 13 laboratory-confirmed and 235 epi-linked).

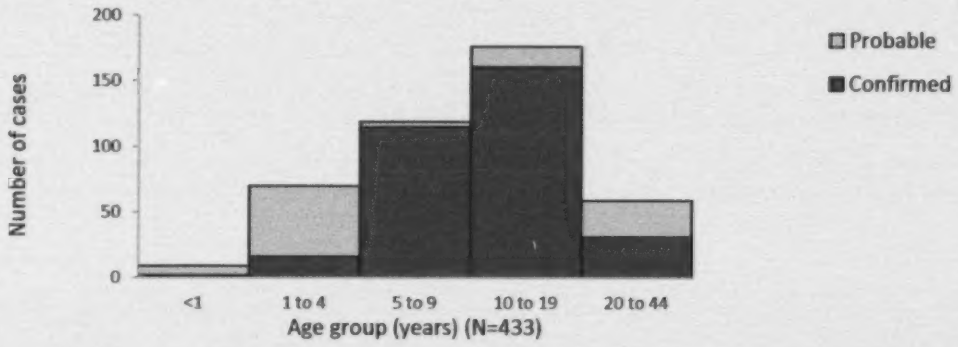
There were 33 (8%) laboratory-confirmed cases (29 by PCR and four by IgM serology), 108 (25%) probable cases and 292 (67%) epi-linked cases (**Table 1**). The age distribution of cases is shown in **Table 1**. The median age was 11 years. Among all 433 cases, only nine (two percent) were under one year of age, 70 (16%) were one to four years, 295 (68%) were among school-age children five to 19 years and 59 cases (14%) were 20 to 44 years. Confirmed cases were less likely to be under five years of age and more likely to be five to 19 years (**Figure 2**), likely an artifact of the school attendance component of the epi-linked case definition. Fifty-one percent of cases were male.

Table 1: Characteristics of outbreak cases by case status, British Columbia,* 2014

Characteristic	Confirmed cases N=325		Probable cases N=108		All cases N=433	
	n	%	n	%	n	%
Case classification						
PCR confirmed	29	-	-	-	29	7
IgM confirmed	4	-	-	-	4	1
Epi-linked confirmed	292	-	-	-	292	67
Probable	-	-	108	-	108	25
Age group (years)						
<1	2	1	7	6	9	2
1 to 4	16	5	54	50	70	16
5 to 9	115	35	4	4	119	27
10 to 19	161	50	15	14	176	41
20 to 44	31	10	28	26	59	14
Sex						
Male	166	51	56	52	222	51
Female	159	49	52	48	211	49
Objects to vaccination						
No	16	5	3	3	19	4
Yes	266	82	90	83	356	82
Unknown	43	13	15	14	58	13
Immunization history						
0 doses	281	86	93	86	374	86
1 dose documented	1	0	2	2	3	1
2 doses documented	1	0	1	1	2	0
Unknown	42	13	12	11	54	12

*One resident of Washington State developed measles following exposure in Fraser East and was the source of infection for five additional cases reported in Washington State. These six cases are not included among the 433 described here.

Figure 2: Number of cases by age group and case status



Most cases (356 cases, 82%) reported objection to vaccination and only 19 cases (4%) reported non-objection. This status was not reported for 58 cases (13%). Only five cases (one percent) reported prior receipt of at least one dose of MCV. The sex distribution and vaccination status were similar for confirmed and probable cases. None of the outbreak cases reported travel during their exposure period. Three cases had pneumonia, one case had a febrile seizure and one case had encephalitis and recovered. There were five hospitalizations and no fatal outcomes. Only five cases were identified in individuals who were not members of the religious community, including three cases from one family cluster with two unvaccinated children and two cases who reported receipt of two doses of MMR vaccine. Spread outside of the religious community was also contained by relatively high rates of measles vaccine coverage. In the region overall, 90% of 7-year olds were complete for two doses of MCV in 2014.

The measles virus genotype was D8 for 28 PCR confirmed cases. Of these, 27 were identical to the MVs/Taunton.GBR/27.12 sequence variant (the same as the strain associated with the Netherlands outbreak) and one was 99.8% identical.

Discussion

This large 2014 BC measles outbreak in a faith-based community known for low-vaccination rates largely affected the pediatric-age population which is compatible with acquisition of measles immunity by adult members due to prior wild-type measles infection. The epicenter was a school which facilitated rapid and intense transmission. Although vaccine hesitancy persisted in this population, containment of the outbreak was facilitated by a high degree of community cooperation with infection control measures and restriction of movement.

While 433 cases were reported, the true number of cases is likely to have been higher as this community is known to not seek medical diagnosis and treatment. Many members of this community do not subscribe to the provincial health care plan and cannot be tracked in administrative data bases. The outbreak was contained to the affected community with only five cases reported among non-community members despite recognized potential transmission events including on public transit, in health care facilities and in post-secondary educational institutions. This suggests adequate population-level immunity in the surrounding community despite suboptimal coverage rates as assessed at specified milestones.

One of the strengths of the outbreak response was the prior formation of a productive working relationship between local public health and the leadership in the Dutch Reformed communities. The relationship that was built with the community prior to this outbreak proved invaluable as a level of trust had already been established. The use of a nurse with direct ties to the community further enhanced communication and comfort level between the community and the health authority. This relationship allowed the community to play an active role in controlling the spread of the outbreak while maintaining their own faith-based practices. Timely reporting and community compliance and enforcement of public health measures, particularly travel restrictions during the critical spring break period, prevented measles cases from reaching denser population areas where further transmission could have occurred.

Faith-based unvaccinated communities remain vulnerable to vaccine preventable diseases. Such communities have experienced episodic outbreaks of polio, measles, rubella and mumps with transmission across international borders due to frequent travel to visit family and friends in related communities (13-17). Local public health units serving such communities are increasing their capacity and shared learning from each other's experiences to tailor their response to optimize outbreak control for these populations.

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Many staff of Fraser Health Authority were involved in data collection during the outbreak. The BC Public Health Microbiology and Reference Laboratory conducted all diagnostic testing for measles and the National Microbiology Laboratory, Public Health Agency of Canada, conducted confirmatory testing and genotyping.

Conflict of interest

None

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Maintaining measles elimination in Canada: Moving forward

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Abstract

Due to the success of immunization and timely surveillance, Canada has not reported any cases of endemic measles since 1998. However, recent large outbreaks of imported-related measles have highlighted the risks of reintroduction of disease through travel and immunization coverage gaps in sub-populations.

Building on its 2011 Elimination Report and in collaboration with provincial and territorial partners, the Public Health Agency of Canada has been promoting immunization, expanding the information gathered in immunization coverage surveys, piloting enhanced surveillance with real-time notifications of suspected and confirmed cases to enable early detection of outbreaks and strengthening its laboratory capacity. As these efforts are consolidated, this approach may become a model for other countries around the world as they seek to achieve measles elimination goals.

Introduction

Canada has been committed to the elimination of endemic measles since its establishment as a national goal at the 1992 Consensus Conference (1). Elimination of measles is achieved when indigenous measles transmission is interrupted for 12 consecutive months or greater (2). With the success of two-dose routine immunization programs and catch-up campaigns, there have been no cases of endemic measles reported since 1998 (3). This significant achievement highlights the collaborative effort undertaken by all levels of government, healthcare providers, non-governmental organizations, expert stakeholders and the Canadian public.

Until global eradication of measles is achieved, imported cases of disease (i.e., exposure which occurs outside Canada) are expected to continue. Since elimination, the number of measles cases has been low with a median annual incidence of 0.87 per 1,000,000 population (Canadian Measles and Rubella Surveillance System [CMRSS] unpublished data). However in recent years, large outbreaks have occurred as a result of importations in communities with inadequate vaccination coverage in Canada and other countries that have achieved elimination status in the World Health Organization (WHO) Region of the Americas (i.e., United States, Brazil) (4).

Acknowledging the challenges of maintaining measles elimination, the Pan American Health Organization (PAHO) adopted a resolution at the 150th Session of the PAHO Executive Committee for an emergency plan of action urging all Member States to strengthen disease surveillance and vaccination coverage in order to maintain elimination status (5). While Canada has successfully contained past outbreaks, an enhanced effort to sustain measles elimination is required.

In 2011, the Public Health Agency of Canada (the Agency) submitted the Elimination of measles, rubella and congenital rubella syndrome in Canada: Documentation and verification report to PAHO (6). This report presented evidence on measles elimination in Canada and provided recommendations for sustaining elimination status in key areas including: 1) immunization promotion and immunization coverage monitoring; 2) surveillance and outbreak response; and 3) laboratory capacity. The Agency is assessing current activities in each of these focus areas to strengthen Canada's approach on maintaining elimination.

Immunization promotion and immunization coverage monitoring

Sustaining measles elimination requires at least 95% vaccine coverage for all population cohorts (7). In Canada, current national estimates of childhood measles vaccination indicate adequate coverage with 95% of all children receiving two doses of a measles-containing vaccine by age seven (8). However, immunization coverage at the provincial/territorial/local levels is heterogeneous with sub-populations where vaccination uptake is suboptimal or vaccination is refused. The 2014 BC outbreak (9) and the recent Quebec outbreak in early 2015 (4) are examples of measles imported into a community where vaccinations were refused for religious/philosophical reasons. Those who refuse all vaccines represent only a small part of the continuum of vaccine hesitancy (10). Some parents may delay or be selective in providing all routine vaccinations for their children, resulting in individuals susceptible to infection (10).

The Strategic Advisory Group of Experts (SAGE) on Immunization Working Group on Vaccine Hesitancy recommends countries have a plan to measure and address vaccine hesitancy as part of their immunization program activities (11). Through the Canadian National Immunization Strategy, an expert Vaccine Acceptance and Uptake Working Group has been formed to address issues of vaccine access and uptake in order to contribute to improving vaccine coverage levels in Canada. The Agency continues to promote immunization through dissemination of educational material for the public and supporting innovative initiatives such as ImmunizeCA, a free mobile vaccine application to help Canadians easily track their immunization records (12).

In the absence of a national network of immunization registries, periodic population-based surveys are necessary to verify adequate national immunization coverage. The Agency monitors national measles immunization coverage through the Childhood National Immunization Coverage Survey (cNICS) (8). The sample for the 2013 survey cycle has been expanded to provide estimates at the provincial and territorial levels. The healthcare provider validation phase was completed in 2014 and the survey results are expected to be published later this year. Parental knowledge, attitudes and behaviours regarding vaccination are also captured in cNICS to better understand the factors influencing immunization decisions.

A national network of immunization registries allows Canada to plan and target immunization efforts, avoid unnecessary duplication of vaccination and facilitate outbreak responses. The Agency continues to support the Canadian Immunization Registry Network and other standard-setting organizations to promote national standards for immunization registries and facilitate the transfer of electronic immunization records between registries. National standards for immunization coverage assessment are published on the Agency website (13). Barcode standards for vaccine products and functional standards for immunization registries will be available in 2015 and by the end of 2016, respectively..

Surveillance and outbreak response

A key component of managing imported cases and ensuring a quick and effective outbreak response is early detection via comprehensive surveillance activities. From 1998 to 2014, there have been 159 identified measles importations from 37 different countries and only 28% of the imported cases resulted in secondary transmission (CMRSS unpublished data). Measles cases are captured primarily by CMRSS through weekly reports from provinces and territories (14).

An Agency pilot project, Measles and Rubella Surveillance (MARS) is a web-based system which provides real-time notifications of suspected and confirmed cases. Since 2011, MARS has been implemented in three jurisdictions (British Columbia, Alberta and Newfoundland). It provides a platform for epidemiological and laboratory data linkage from provincial laboratory, provincial public health unit and national medical laboratory partners. As part of the Agency's priorities to expand real-time access to public health information, MARS will be offered to other jurisdictions in late 2015.

While measles outbreaks are rare in the post-elimination era, larger outbreaks can be a tremendous burden on public health resources. There is a paucity of data on the costs associated with the control of measles outbreaks in Canada and estimates have been limited. In 2014, an outbreak of four measles cases in Ottawa required the involvement of 60 public health employees who logged 1,400 work hours (15). This created a $28,000 (CDN) deficit in the local public health unit's first quarter budget (16).

The Agency provides guidance to provinces/territories in supporting investigation and control of outbreaks. In an effort to provide the best available evidence, the Agency collaborated with the Canadian Agency for Drugs and Technologies in Health (CADTH) to conduct a systematic review on interventions to reduce secondary spread of measles (17) and a cost analysis to estimate resource use associated with measles outbreaks (18).

Laboratory capacity

Molecular surveillance and genotyping (the process of determining differences in the genetic make-up of an organism) is essential for understanding measles epidemiology in Canada. It is an invaluable tool for public health investigation for confirming exposure history, determining links between concurrent outbreaks and identifying potential sources of importations (19). Additionally, it allows us to verify Canada's elimination status by distinguishing between different strain variants and widespread circulation of one strain.

As we move toward global eradication of measles, the genomic diversity of the virus will decrease. As such, it will become increasingly difficult to distinguish multiple importations from endemic transmission when sporadic cases have the same genetic sequence. Extended genotyping will be required more frequently for adequate surveillance.

The Agency's National Microbiology Laboratory (NML) is a designated PAHO/WHO measles regional reference laboratory and is responsible for genotyping and enhanced molecular surveillance of all measles specimens in Canada. NML continues to explore innovative methods for enhancing measles virus sequencing to provide timely results in aiding outbreak investigations.

Conclusion

With ongoing measles activity in other regions of the world, Canada's elimination status will continue to be challenged and will likely result in limited outbreaks, as seen recently in BC (9) and Quebec (4). The threat of importations, combined with suboptimal vaccination coverage in sub-populations, poses a risk of reintroduction of disease. In order for Canada to sustain measles elimination, enhancing current programs and continuing collaboration at all levels of government is required. Building on the recommendations in its 2011 Elimination Report (6), the Agency has been promoting immunization, expanding the information gathered in immunization coverage surveys, piloting enhanced surveillance with real-time notifications of suspected and confirmed cases to enable early detection of outbreaks and strengthening its laboratory capacity. As these efforts are consolidated, this approach may become a model for other countries around the world as they seek to achieve measles elimination.

Conflict of interest

None

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ID News: Ebola update

World Health Organization. **Ebola situation report update Jun 17, 2015**. (*Summary*)
http://apps.who.int/ebola/ebola-situation-reports

There have been a total of 27,305 reported confirmed, probable and suspected cases of Ebola Virus Disease (EVD) in Guinea, Liberia and Sierra Leone with 11,169 reported deaths. (This total includes reported deaths among probable and suspected cases, although outcomes for many cases are unknown). In the week prior to June 14, a total of 10 new confirmed cases were reported in Guinea and 14 new cases in Sierra Leone.. The total number of confirmed cases is similar in males and females. Compared with children (people aged 14 years and under), people aged 45 and over are four to five times more likely to be affected than children. A total of 869 confirmed health worker infections have been reported in Guinea, Liberia and Sierra Leone and there have been 507 reported deaths

Boggild AK, Esposito DH, Kozarsky PE, Ansdell V, Beeching NJ, Campion D, et al. **Differential diagnosis of illness in travelers arriving from Sierra Leone, Liberia, or Guinea: A cross-sectional study from the GeoSentinel Surveillance Network**. Ann Intern Med. 2015 May12. doi: 10.7326/M15-0074. (*Summary*)
http://www.ncbi.nlm.nih.gov/pubmed/?term=Boggild+AK%2C+Esposito+DH%2C+Kozarsky+PE%2C+Ansdell+V%2C+Beeching+NJ%2C+Campion+D%2C

Objective: To define the spectrum of illness observed in persons returning from areas of West Africa where EVD transmission has been widespread.
Design: Frequencies of illnesses reported in 805 ill returned travellers and new immigrants from Sierra Leone, Liberia, or Guinea seen between September 2009 and August 2014 in 57 travel or tropical medicine clinics in 25 countries using GeoSentinel records.
Results: The most common specific diagnosis among 770 nonimmigrant travellers was malaria (n=310 [40.3%]), with Plasmodium falciparum or severe malaria in 267 (86%) and non-P. falciparum malaria in 43 (14%). Acute diarrhea was the second most common diagnosis among nonimmigrant travellers (n=95 [12.3%]). Common diagnoses, such as upper respiratory tract infection, urinary tract infection and influenza-like illness, occurred in only 26, nine and seven returning travellers, respectively. Few instances of typhoid fever (n=8), acute HIV infection (n=5) and dengue (n=2) were encountered.
Conclusion: Although EVD may currently drive clinical evaluation of ill travellers arriving from Sierra Leone, Liberia and Guinea, clinicians must be aware of other more common, potentially fatal diseases. Malaria remains a common diagnosis among travellers seen at GeoSentinel sites. Prompt exclusion of malaria and other life-threatening conditions is critical to limiting morbidity and mortality.

Heymann DL, Chen L, Takemi K, Fidler DP, Tappero JW, Thomas MJ, et al. **Global health security: The wider lessons from the west African Ebola virus disease epidemic.** The Lancet. May 2015;385:1884–1901. (*Summary*)
http://www.ncbi.nlm.nih.gov/pubmed/?term=Heymann+DL%2C+Chen+L%2C+Takemi+K%2C+Fidler+DP%2C+Tappero+JW%2C+Thomas+MJ%2C

The Ebola virus disease crisis has drawn attention to the well-recognized importance of reducing collective vulnerability to infectious disease threats that cross national borders. The crisis revealed countries' lack of political commitment to global health security, battered WHO's credibility and highlighted non-compliance with international health law. It has nonetheless resuscitated interest in global health security.The epidemic has shown how we are only as safe as the most fragile states and is a reminder that improvement of the capacity of every country to find, stop and prevent health threats is in the world's self-interest. Setting of priorities and allocation of resources to mitigate the effect of and recovery after conflict and natural disaster is a quintessentially political challenge, not merely a technical one. Both individual and collective health security are intimately tied up with successfully meeting this challenge. In safeguarding global health security, it is important to pay attention to migration. Fuller implementation of the International Health Regulations in West Africa would have been a far more effective safeguard against migration than travel restrictions.